

Operation Iraqi Freedom: Surgical Experience of the 212th Mobile Army Surgical Hospital

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Seven hundred one patients were treated at and 394 were admitted to the 212th Mobile Army Surgical Hospital in Central Iraq during the combat phase of Operation Iraqi Freedom. Ninety of those patients underwent 100 operations, with 187 procedures in 19 days. At the peak of hostilities, 48 patients were admitted, 15 operations were performed, and 56 patients were medically evacuated during different 24-hour periods. Thirty-three patients required the surgical expertise of a general or thoracic surgeon. Although 82% of injuries and 70% of the procedures were orthopedic in nature, orthopedic operating room utilization was only 60% of total operating room time (156 hours). The general and thoracic injuries were labor-intensive, frequently requiring two surgeons. Although orthopedic injury remains the predominant reason for surgical intervention on the battlefield, there remains a need to forward-deploy general and thoracic surgeons, because of the presence and complexity of nonorthopedic trauma.

Introduction

The 212th Mobile Army Surgical Hospital (MASH) was the first Army hospital to cross into Iraq at the start of Operation Iraqi Freedom. As a completely mobile, 36-intensive care unit bed hospital configured for rapid relocation and set-up, the MASH was uniquely qualified to assume the role as the most forward-deployed level III hospital to receive casualties during the initial weeks of combat operations in Iraq.¹ This article describes the 19-day surgical experience of the 212th MASH during Operation Iraqi Freedom, with commentary on lessons learned.

Methods

Population

Seven hundred one patients were treated in the emergency department at Logistical Staging Area Bushmaster, located just south of An Najaf, Iraq, between March 26 and April 14, 2003. Of the 394 patients admitted to the hospital, 262 patients were U.S. soldiers and 132 were enemy combatants (ECs) or civilian noncombatants. One hundred eighty-nine of the U.S. soldiers were admitted to the MASH for treatment of traumatic injuries

sustained while in a combat zone. Seventy-four U.S. soldiers and all 132 Iraqi patients had true battle injuries, defined as injuries caused by enemy fire. One hundred fifteen U.S. soldiers were admitted for treatment of injuries not caused by enemy fire. The remaining 73 U.S. soldiers were admitted for treatment of nonbattle-related disease. The mean daily admission rate was 20.7 patients. Forty-eight patients each were admitted to the 212th MASH on April 4 and 5, 2003. A maximum of 37 U.S. soldiers were admitted on April 4, whereas 26 Iraqi EC patients were admitted on April 5, 2003.

Ninety patients underwent 100 operations between March 27 and April 14, 2003. Forty-seven patients were U.S. soldiers and 37 were ECs. Six patients were civilian noncombatants, including three children (4, 7, and 8 years of age). These 90 patients constitute the study group.

Study Design

Demographic and surgical data, including patient status (U.S. soldier, EC, or civilian), patient age, date of operation, operating surgeons, and number, type, and duration of procedures performed, were prospectively obtained. The data were accumulated to appropriately and adequately answer questions raised during the after-action review process for unit performance improvement and to avoid drawing incorrect conclusions from data that in past wars were difficult to obtain retrospectively.² Our data were subsequently analyzed in a retrospective manner.

Fifty-three patients required more than one procedure, as a result of sustaining trauma to multiple areas. A patient who underwent a combined neck exploration and median sternotomy was counted as having two procedures. Similarly, patients who underwent debridement and irrigation (D&I) of an extremity and subsequent placement of an external fixator were listed as having two procedures. In total, 187 procedures were performed during 100 operations for 90 patients. The locations of injuries correlating with procedures are shown in Table I.

Results

There were 99 operations required for traumatic injuries. Forty of the 47 U.S. soldiers required operations for treatment of battle injuries. The remaining seven U.S. soldiers underwent operations for treatment of the following nonbattle injuries: one self-inflicted gunshot wound to the foot from an M16 rifle and one from a 9-mm pistol; one self-inflicted finger amputation from a traumatic fall from a chair and one sustained while working on a running engine; one femur fracture as a result of leg malposition near the breech of an Abrams M1 tank; and one chest injury incurred while working too near another soldier.

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This work was presented at the American College of Surgeons 89th Annual Clinical Congress, General Session 56: Casualty Management in the 2003 Iraq War, Chicago, IL, October 20–23, 2003, and the 18th Uniformed Services University of the Health Sciences Surgery for Trauma Day, Transfer of Training and Technology to the Front: Lessons Learned, Bethesda, MD, August 21, 2003.

This manuscript was received for review in March 2004 and was accepted for publication in April 2004.

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 APR 2005	2. REPORT TYPE N/A	3. DATES COVERED -			
4. TITLE AND SUBTITLE Operation Iraqi Freedom: surgical experience of the 212th Mobile Army Surgical Hospital			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Cho J. M., Jatoi I., Alarcon A. S., Morton T. M., King B. T., Hermann J. M.,			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX 78234			8. PERFORMING ORGANIZATION REPORT NUMBER		
			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
			12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited		
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 6	19a. NAME OF RESPONSIBLE PERSON
a REPORT unclassified	b ABSTRACT unclassified	c THIS PAGE unclassified			

TABLE I

LOCATIONS OF INJURIES AMONG U.S., EC, AND CIVILIAN PATIENTS

Location of Injury	No.			
	U.S. Soldier	EC	Civilian	Total
Thorax	2	3	2	7
Abdomen	4	7	0	11
Buttock	1	3	0	4
Perineum	0	2	0	2
Right upper extremity	5	1	1	7
Right hand and wrist	3	4	0	7
Left upper extremity	6	5	1	12
Left hand and wrist	10	3	1	14
Right lower extremity	12	22	1	35
Right foot	4	3	0	7
Left lower extremity	11	14	0	25
Left foot	2	4	1	7
Face or scalp	6	4	0	10
Back	0	0	1	1
Neck	2	0	0	2

who inadvertently discharged a M203 round while cleaning the weapon. The remaining U.S. soldier underwent an emergency appendectomy, the sole non-trauma-related operation. Ten EC patients required return to the operating room (OR) for planned extremity D&I 48 hours after the initial operation. A total of 17.9% of U.S. patients admitted to the MASH underwent operative intervention. If only U.S. soldiers admitted for trauma are considered, then the rate increases to 24.9%. The surgical intervention rate for U.S. soldiers admitted for battle injuries was 54.1%. The admission for operative intervention rate for Iraqis was 35.6%.

Thirty-three patients (32% U.S. and 42% Iraqi) required the surgical expertise of a general or thoracic surgeon (Table II). The most common operation was exploratory laparotomy. Of note, 7 of 11 exploratory laparotomies were negative for intra-abdominal trauma. Six thoracic operations were performed. Two patients underwent median sternotomy. One minithoracotomy and one posterolateral thoracotomy were required because of incomplete hematoma evacuation, 1 and 7 days after injury. Two neck explorations were performed, for a zone I injury and a zone II injury. Seventeen of these 33 patients also required an orthopedic surgeon because of concomitant extremity trauma. The remaining 57 patients had injuries requiring only an orthopedic surgeon (Table III). In all, 74 patients underwent at least one orthopedic procedure. The most common operation was an extremity D&I of a gunshot wound or shrapnel injury ($n = 108$). Seventeen external fixators were placed, and two subsequent external fixator readjustments were performed.

Thirteen patients each underwent at least one operation from midnight to midnight on April 4 and 8, 2003 (Fig. 1). The maximum number of patients who underwent an operation in any given 24-hour period was 15. Twelve U.S. soldiers required operations on April 8, whereas 10 Iraqi ECs required operations on April 11. Two patients required five procedures to repair all injuries. The total number of procedures performed was 187. The mean number of procedures per patient was 2.08.

Only one surgeon was required for 54 of the 100 surgical cases. Two surgeons participated in 40 of the more complex surgical cases. Three surgeons were needed for five cases. These

TABLE II

FIFTY-FIVE GENERAL OR THORACIC SURGICAL PROCEDURES PERFORMED FOR 33 PATIENTS

Procedure	No.
Thoracic	11
Median sternotomy	2
Evacuation of hematoma	2
Posterolateral thoracotomy	3
Phenorraphy	1
Decortication	1
Closure emergency thoracotomy	1
Mini-lateral thoracotomy	1
Zone I/II neck exploration	2
Major vascular reconstruction, popliteal artery/vein revascularization with autologous saphenous vein	1
Abdominal	16
Exploratory laparotomy	11
Rectal injury/colostomy	2
Liver laceration repair	1
Phenorraphy	1
Small-bowel repair	1
Major scalp lacerations	1
Washouts (D&I)	24
Face/scalp	8
Buttock	4
Perineum	2
Back	1
Abdomen/flank	7
Chest	2

TABLE III

ONE HUNDRED THIRTY-TWO ORTHOPEDIC PROCEDURES PERFORMED FOR 74 PATIENTS

Procedure	No.
External fixators	17
Femur	11
Tibia	4
Humerus	2
External fixator readjustment	2
Washouts (D&I)	108
Right upper extremity	4
Right hand and wrist	8
Left upper extremity	12
Left hand and wrist	14
Right lower extremity	34
Right foot	6
Left lower extremity	24
Left foot	7
Completion amputations	4
Arm	2
Leg	2
Four-compartment leg fasciotomy	1

five patients required the expertise of both an orthopedic surgeon and a general or thoracic surgeon. One patient who underwent simultaneous exploratory laparotomy and popliteal artery and vein reconstruction, with subsequent fasciotomy, required the expertise of five surgeons. The total operative time for this case was 320 minutes.

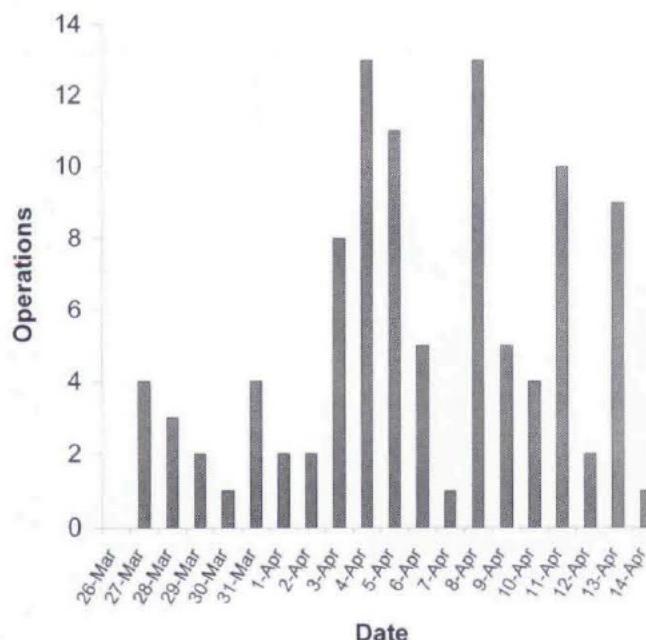


Fig. 1. Operations performed at the 212th MASH from March 26 to April 14, 2003.

Three OR tables were used for a total of 156 hours (OR table utilization). Two of the OR tables were in one International Standard Organization (ISO) expandable OR, and the forward surgical team (FST) OR table was located at the rear of the emergency department section. Fifty-six percent of the operations were performed while another patient was in the same ISO OR, on the second OR table. Often surgeons were operating on a patient with orthopedic injuries while other surgeons were exploring an abdomen or chest. One hundred thirty-two orthopedic procedures required 94 hours of OR table time. The mean time per orthopedic procedure was 43 minutes. Seventeen external fixators placed after D&I required an average of 85 minutes, with a range of 60 to 125 minutes. Fifty-five general or thoracic surgical procedures used 62 hours of OR table time, with a mean procedure time of 87 minutes. The average time required for an exploratory laparotomy was 100 minutes. The mean time for six thoracic surgical procedures was 120 minutes, with a range of 40 to 185 minutes. Although 82% of the patients had some type of orthopedic injury, only 60% of the OR utilization was for orthopedic procedures. The remaining 40% of OR table use required a general or thoracic surgeon. These operations usually required the services of at least two surgeons. A majority of these injuries occurred among EC and civilian patients (Table IV).

The FST table, with the full complement of anesthesia and OR technician (91D) support, was used twice as a third OR table. In

addition, 15 minor procedures were performed on the FST table. These procedures were performed without an anesthesia provider or an OR technician or nurse. These procedures are not included in this study.

The 212th MASH deployed with one thoracic surgeon (61K), three general surgeons (61J), one orthopedic surgeon (61M), and one gynecologist (60J). One general surgeon had received additional subspecialty training in plastic and reconstructive surgery. On April 3–5, 2003, the MASH was augmented by an orthopedic surgeon from the 28th Combat Support Hospital (CSH). Thereafter, a general or thoracic surgeon assisted or performed extremity procedures under the direction of the orthopedic surgeon. Seven of the 17 external fixators were placed by general or thoracic surgeons under the direction of the orthopedic surgeon. In addition, 38 D&I procedures were performed by a general or thoracic surgeon. Nonorthopedic surgeons participated in 32% of the orthopedic surgery workload. With the 10 face or scalp and 11 buttock, perineum, and flank D&I procedures, 59 of the 113 cases (52.2%) had a general or thoracic surgeon as the surgeon or first assistant.

Discussion

When the ground offensive for Operation Iraqi Freedom commenced on March 20, 2003 (G Day), the 212th MASH was deployed along the Iraqi-Kuwaiti border at Camp Udairi, Kuwait. The following morning, soldiers of the MASH Hospital Unit, Surgical Forward, moved into Iraq. The main element of the MASH left Kuwait 6 hours later. The MASH moved 270 miles in 78 hours and set up at Logistical Staging Area Bushmaster, located 20 miles south of An Najaf, Iraq. On March 26 (G Day + 6), the MASH was fully complexed and ready to receive patients. The MASH was well positioned to receive casualties as the elements of the Army's 3rd Infantry Division and 101st Airborne Division pushed through the Karbala Gap, en route to Baghdad. The spike in the number of patients treated is a reflection of the battles that ensued in the days before the liberation of Baghdad (Fig. 1).

The mean daily admission rate for the 212th MASH during Operation Iraqi Freedom was similar to that of a CSH during Operation Desert Storm (21.7 and 29.5 cases, respectively). However, the admission rate for the MASH was sustained for >19 days, compared with 4 days for the CSH. On two separate occasions, 48 patients were admitted to the MASH. These patients were triaged without calling a hospital-wide mass casualty. Soldiers of the service and supply platoon were used, and intensive care unit personnel on duty were brought forward to the emergency department, eliminating the need to mobilize the entire MASH. This allowed conservation of medical manpower to ensure successful sustained operations for 19 days.

TABLE IV
COMPARISON OF U.S. SOLDIERS AND IRAQI PATIENTS

	No. with Injury				Combination
	A: Trunk and Neck	B: Extremity	C: Face/Scalp	A and B	
U.S. soldiers (N = 47)	4	32	3	4	4
Iraqi (N = 43)	9	25	0	7	2

Many of the injuries were related to combat but not to direct enemy gunfire. These nonbattle injuries are a reflection of the austere environment and conditions to which warfighters are subjected.⁴ Injuries were a result of ground vehicle and helicopter accidents, accidental and self-inflicted injuries, and friendly fire. The only known incidence of friendly-fire injury was from an incidental discharge of a M203 grenade launcher, as previously described. A majority of patients with nonbattle injuries sustained blunt trauma. As a result, only 6% of patients with nonbattle injuries underwent surgical intervention. These results were similar to those seen in postwar Iraq during Operation Desert Storm and in Bosnia-Herzegovina during NATO peacekeeping efforts in 1995–1999.^{5,6}

The surgical intervention rate at the 212th MASH for battle-related injuries was higher for U.S. soldiers than for Iraqi ECs (54.1% vs. 35.6%). We defined this rate as the percentage of battle-injured patients who underwent an operation at the MASH. Mechanisms for triage could not account for this difference, because decisions to proceed to the OR were based on indications for surgery and not on the category of the patient (U.S. vs. Iraqi). Actually, 40% of Iraqi ECs received their initial operation at the more forward-deployed FST. These patients were then sent back to the 212th MASH en route to definitive postoperative care at the 86th CSH Forward. Because these patients were held <48 hours at the MASH, there was no need for planned return to the OR for extremity washout. When these patients were included, the surgical intervention rate for Iraqi ECs increased to approximately 76%. Only 20% of U.S. soldiers underwent an initial operation at a FST. When this percentage was added to the 54.1% U.S. soldier surgical intervention rate at the MASH, the combined percentage of 74% was similar to the Iraqi EC rate. These rates of surgical intervention for U.S. and Iraqi patients were much higher than the reported 27% and 28% rates recorded by a CSH during Operation Desert Storm.⁷ The higher rates of surgical intervention may be attributable to the forward deployment and synergy of surgical expertise found within the FST and the MASH.

The reason why only 20% of U.S. soldiers arriving at the MASH received their initial operation at an FST was certainly not because of a lack of surgical capability. The FST configuration provides the necessary speed of relocation and set-up required on today's battlefield.⁸ Most FSTs consist of three or four surgeons, including at least one general surgeon and one orthopedic surgeon.⁹ The best explanation for this may be that the MASH remained "fixed" in location once in an area south of An Najaf. This enabled medical evacuation units to find the MASH without much difficulty. However, many of the FSTs moved with the maneuver units. One unit, the 555 FST, moved five times in 10 days. Perhaps more effort was required to find these smaller medical units.

Thoracic and abdominal trauma requiring an operation was twice as prevalent among Iraqi patients ($n = 12$; 28%), compared with U.S. patients ($n = 6$; 13%). Rates of injury to the truncal area were probably much higher for Iraqi ECs, because many Iraqis injured in this area sustained lethal injuries, died on the battlefield, and therefore did not present to a hospital. More than 51% of the surgical interventions performed at an Iranian hospital during the 8-year Iran-Iraq War were for injuries to the chest or abdomen.¹⁰ These patients were without protective ar-

mor. The body armor worn by U.S. soldiers was clearly the main reason why fewer injuries were noted among U.S. soldiers. The 13% operative intervention rate for truncal trauma among U.S. soldiers was similar to the 15.1% reported by VII Corps surgeons during Operation Desert Storm.⁴ In Operation Iraqi Freedom, however, U.S. soldiers who required an operation involving the trunk sustained mostly high chest or low abdominal trauma. Procurement of personal protection that covers the neck and perineum should further decrease injury rates among our soldiers.

One of the great successes during the combat phase of the war was the ability to quickly air-evacuate patients to the rear. During two separate 24-hour periods, 56 patients were evacuated from the 212th MASH to Army hospitals in southern Iraq or Kuwait. Solidification of policies and procedures during predeployment checks and training, combined with the use of advanced technology to facilitate medical communication, contributed to the successful transfer of patients to rear echelons.¹¹ Very few patients stayed at the MASH long enough to return to the OR for planned extremity D&I. The exception was one group of 10 patients who could not be evacuated because of intense sandstorms. The remaining 64 patients with extremity trauma received only one operation at the MASH.

There were 11 exploratory laparotomies performed during this deployment, and no injuries were found in seven cases. There are several possible reasons for such a high rate of "negative laparotomies." First, computed tomography and laparoscopy can reduce the need for exploratory laparotomies, but these diagnostic modalities were not available at the MASH.¹² Second, nonoperative management (observation) was generally not an option, because our bed capacity was limited, and patients were evacuated to rear-echelon hospitals within 12 to 48 hours after admission. Nonoperative management is ideal when a surgeon can observe the patient over a period of time. This is generally not feasible in a field setting, where several physicians at different echelons of care are responsible for patient management.

Four of the seven patients with negative laparotomies presented with gunshot wounds to the flank. In all instances, these patients underwent initial local exploration of their wounds but the extent of the injuries could not be determined in this manner. Therefore, exploratory laparotomy was required to exclude possible retroperitoneal injuries. One patient underwent reexploration after surgery at a FST because of suspicion of a retained laparotomy pad. The remaining two cases involved patients who sustained gunshot wounds to the anterior abdomen. These patients were found to have wounds that penetrated deep into the abdominal wall but did not enter the peritoneal cavity. The missile tract in each case was tangential, and local wound exploration yielded equivocal findings.

Two of the six patients who underwent thoracic procedures would have benefited from video-assisted thoracic surgery. In both cases, use of video-assisted thoracic surgery for incompletely evacuated hematomas would have eliminated the need for a lateral thoracotomy. Because one patient was a U.S. soldier, this might have allowed the soldier to return to duty after a period of postoperative observation at the MASH. In addition, the four patients who underwent exploration because of a flank injury might have benefited from laparoscopic procedures to

determine whether the peritoneum had been entered. However, specialized videoscopic equipment is quite bulky. There is limited space in the MASH to tow the additional equipment required to perform minimally invasive procedures. If specialized equipment were subjected to such an austere environment as Iraq, there might be a greater propensity for the equipment to break down. In addition to the difficulty of having contractor service equipment in the field, the current approach appears to be a safe solution. Surgeons deployed to Afghanistan in support of Operation Enduring Freedom appear to have come to the same conclusion.¹¹

In general, the more complex operations required the expertise of a general or thoracic surgeon. However, given the high percentage of orthopedic cases, is the surgeon composition appropriate in a MASH configuration? We think that the current mix of surgeons is an acceptable solution if the thoracic and general surgeons take an active interest in performing or assisting in orthopedic surgery. Otherwise, a second orthopedic surgeon would be a valuable adjunct to the MASH. Although 82% of injuries and 70% of procedures were orthopedic in nature, orthopedic OR utilization was only 60% of total OR time (156 hours). Extremity injuries requiring an orthopedic surgeon, as a percentage of total injuries, increased to a range of 60 to 90% in wars after the Vietnam War.^{5,6,13-15} This is an increase from the 50% noted in World War II, the Korean War, and the Vietnam War.⁴ In our series, 82% of patients had at least one orthopedic injury. However, 104 of these operations were simple gunshot wound or shrapnel wound washouts (D&I). In fact, nonorthopedic surgeons participated in almost one-third of the orthopedic cases. Because the Army Medical Department is in constant need of orthopedic surgeons, it makes sense to give general surgeons the tools necessary to assist the orthopedic surgeon or to perform requisite extremity stabilization and debridement.^{16,17} This might include a 1- or 2-week rotation at a busy Army medical center or civilian trauma center, assisting an orthopedic surgeon with washouts and external fixator placement.^{9,16,17} Fortunately for the 212th MASH, the orthopedic surgeon was as interested in teaching his craft as the thoracic and general surgeons were in assisting in orthopedic procedures.

Six thoracic operations, two neck explorations, and a complex peripheral vascular reconstruction would probably not have been performed without the presence of the thoracic surgeon at the 212th MASH. The concept of deploying a thoracic surgeon as far forward as possible is a valid one, because thoracic surgeons are board-certified general surgeons with expertise in large- and small-vessel anastomoses. Thoracic surgeons are equally comfortable treating the chest and abdomen. The one patient with a significant popliteal artery and vein disruption required a contralateral saphenous vein harvest and four anastomoses to salvage the leg. Because such operations can be performed equally well by a vascular surgeon or a general surgeon experienced in vascular techniques, an argument can also be made that each level III hospital should deploy with a surgeon capable of managing large- and small-vessel vascular trauma.^{4,18}

Lastly, effective personnel, space, and time utilization of the OR was demonstrated by simultaneously using two OR tables in one ISO OR. All injured patients were assumed to have contaminated wounds. Two separate surgical teams were used to care for each surgical patient. As a result, the third OR table, located in the emergency department section, was needed only twice. We found that taking patients immediately to the OR once it was determined that there was an indication for surgery was the best way to prevent a backlog of surgical cases.

The 212th MASH was the last MASH in the Army inventory. Under the Army's Medical Reengineering Initiative, this unit was phased out and reflagged as the much larger 12th CSH in October 2004. The MASH configuration and capability continue to exist as a 44-bed portion of the 96-bed CSH. For this reason, lessons learned from the most recent deployment of the 212th MASH to Iraq will continue to be relevant to Army medicine.

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